Surficial Geologic Map Unit Properties Table: Delaware Water Gap National Recreation Area

Gray-shaded units are not mapped within Delaware Water Gap National Recreation Area.

Age	Map Unit (Symbol)	Geologic Description	Geologic Issues	Geologic Features and Processes	Geologic History
QUATERNARY	Artificial fill (Qafl); Mine dump deposits (Qmd)	**Qafl** consists of loose, unconsolidated mixtures of rock fragments, sand, silt, clay, concrete and manufactured materials put in place by humans. Such materials are usually associated with construction, road development, earthen dams, and railway beds. **Qafl** may be as much as 8 m (25 ft) thick. **Qmd** contains blocks of mine waste, including slate from the Martinsburg Formation, in piles more than 30 m (100 ft) high. Other deposits of **Qmd** contain blocks of siltstone, cherty (siliceous nodules) limestone, dolomite, and shale from mine operations.	**Slope movements**—**Qafl** is susceptible to erosion and slope movements if poorly consolidated. Steeply-sloped piles of **Qmd** may be susceptible to slope movements. **Abandoned mineral lands**—**Qmd** is associated with the long history of mineral and rock resource extraction in the area. Slate quarries and dumps are present on both sides of the Delaware River. **Qmd** is associated with active mines and roadways, and is used as aggregate. **Surface water and groundwater quality and quantity**—units have no surficial aquifer potential.	**Caves and karst**—In the past sinkholes and other karst features may have been filled by human activities. **Connections to park stories and resources**—units are associated with modern or historic human development and/or resource extraction.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qafl** primarily used to raise the land surface, construct earthen dams, and form a solid base for roads and railways. **Qmd** created by mining or quarrying activities.
	Peat (Qp)	**Qp** occurs in poorly drained, natural depressions where the water table is at or near the surface. Examples of such settings include swamps and marshes. **Qp** consists of decaying vegetation and deposits may be more than 3 m (10 ft) thick.	**Slope movements**—**Qs** may be interbedded with colluvium deposits (associated with slope processes). **Qp** and **Qs** are easy to excavate, with low erosion resistance. **River channel migration and flooding**—**Qud** is located along riparian zones of active streams and rivers. **Abandoned mineral lands—**sand and gravel pits may have targeted those resources in these units. Peat from **Qs** was mined near Oak Grove. **Corridor construction projects**—marshy and wetland habitats may be impacted from corridor construction projects. **Surface water and groundwater quality and quantity**—**Qp** and **Qs** have no surficial aquifer potential. Qud units have variable aquifer potential depending on the primary material (alluvium, glacial deposits, etc) at each locality. Because the water table it at or near the surface where **Qp** is mapped, those areas are unsuitable for foundations, septic systems, and sanitary-landfill sites due to the potential for contamination.	**Paleontological resources**—units may contain pollen. **Qs** contains partially decomposed remains of mosses, sedges, trees, and other plants. **Qp** is decayed vegetation. **Connections to park stories and resources**—Units are associated with marshy, wetland habitats and riparian zones. Areas of **Qs** are heavily vegetated. Historically, marshes and swamps were drained to support increased development.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—Glacial deposits of **Qud** are from the most recent major ice-age glaciation (termed the "Wisconsinan") and pre-Wisconsinan glacial advances during the Pleistocene. **Qs** may be accumulating in kettles, shallow postglacial lakes, and hollows in ground moraine that formed after the Wisconsinan glacial advance.
	Undifferentiated surficial deposits (Qud)	**Qud** includes alluvium (deposits associated with streams), swamp deposits, and glacial deposits consisting of clay, silt, sand, gravel, and organic-rich muck.			
	Swamp and marsh deposits (Qs)	**Qs** is loose, unconsolidated clay, silt, and sand mixed with decomposing organic matter in moist, shallow, undrained areas. **Qs** may be as much as 12 m (40 ft) thick and may contain cobbles and boulders.			
	Alluvium (Qal)	**Qal** is deposited by streams along floodplains and channels. Itincludes unconsolidated, poorly layered, poorly to moderately sorted mixtures of (in order of increasing grain size) clay, silt, sand, gravel, cobbles, and occasional boulders.	**Slope movements**—Units have low resistance to erosion and are easily excavated. However they hold relatively low slopes. Slumping is possible. **River channel migration and flooding**—Because units are associated with modern river channels, areas mapped as Qal and Qaf have a high potential for flooding. **Surface water and groundwater quality and quantity**—**Qal** may yield large quantities of water, but may not be sufficiently thick to be a viable source for groundwater. Some groundwater contains excessive concentrations of iron and manganese. Well-sorted sands and gravels in **Qal** of Monroe County constitute one of the most productive aquifers in the county.	**Glacial features and processes**—some deposits of **Qaf** are associated with postglacial and outwash terraces and may be dissected by modern streams. **Connections to park stories and resources**—associated with valley-bottom and riparian habitats.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qal** and **Qaf** are currently accumulating in river and stream channels and along riparian zones. They record the evolution of the modern fluvial system after the retreat of glaciers.
	Alluvial fan deposits (Qaf)	**Qaf** is also associated with rivers, forming smooth, fan-shaped surfaces with low to steep slopes at tributary mouths where two streams come together. Lobes of **Qaf** may dip as much as 30° toward the trunk valley and may be as much as 12 m (40 ft) thick.			

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QUATERNARY	Alluvium and Olean outwash, undifferentiated (Qaoo)	**Qaoo** consists of mixed, unconsolidated alluvium and outwash. Material within **Qaoo** includes clay, silt, sand, gravel, and occasional boulders. Some planar surfaces in the outwash formed as bedding features during deposition. Alluvium, deposited by streams not of glacial origin, tends to be finer grained than outwash that was deposited by glacial meltwater streams. **Qaoo** may occur in lenses several meters thick, or may be up to 150 m (500 ft) thick in deep infilled valleys.	**Slope movements**—erosion resistance is low for this unit and it forms a moderate to poor foundation for heavy structures. Slumping is possible in many places. **Abandoned mineral lands—**sand and gravel pits may have targeted those resources for use as aggregate. **River channel migration and flooding**—Because it is associated with modern river channels, areas mapped as **Qaoo** have a high potential for flooding. **Surface water and groundwater quality and quantity**—High infiltration capacity and good groundwater quality. It is generally unsuitable for septic systems.	None documented.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—Thick deposits of **Qaoo** exist at Matamoras. Sediment mapped as **Qaoo** was derived from Catskill Formation rocks.
	Alluvium and colluvium, undifferentiated (Qac)	**Qac** occurs in valley bottoms and adjacent slopes and consists of stratified (layered), poorly sorted sand, silt, and minor gravel. **Qac** may be as much as 5 m (15 ft) thick.	**Slope movements**—**Qac** is associated with active slope processes and may contain mass-flow deposits. Slumping is possible. Most development should be avoided on this unit due to the active nature of its formation. Erosion resistance is low. **River channel migration and flooding**—**Qac** along streams has a high potential for flooding.	**Connections to park stories and resources**—are associated with valley-bottom, slope, and riparian habitats.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qac** is currently accumulating in river and stream channels and along slopes.
	Boulder accumulations (Qba)	**Qba** contains unsorted mixtures of angular to rounded boulders. Most boulders are less than 1 m (3 ft) in diameter, but some diameters reach 2 m (6 ft) or more. Most boulders are sandstone.	**Slope movements**—**Qba** is associated with active slope processes and is so localized and irregular in surface expression that it is not a viable candidate for much development. Erosion resistance is moderately low.	**Glacial deposits and features**—**Qba** is associated with glacial and periglacial (colder than usual climates near glaciers) conditions that accelerated frost-wedging of large rocks into smaller boulders. **Connections to park stories and resources**—Exposures of **Qba** occur in open flats, below ledges, in small drainages, and around the margins of peat deposits.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—Unit records accelerated weathering and mass-wasting processes associated with cold glacial and periglacial climates.
	Shale-chip rubble (Qsr)	**Qsr** contains unconsolidated, poorly to well-bedded, wedge-shaped deposits of platy fragments of claystone and siltstone. Individual platy fragments are 3 to 5 cm (1 to 2 in) long. Thickness of **Qsr** may reach up to 15 m (50 ft) at the bases of slopes. Beds of **Qsr** dip as much as 25° toward the valleys. Shale colluvium may be interlayered with aeolian sand and alluvium and locally grades to glacial and postglacial stream terraces flanking many valleys.	**Slope movements**—**Qsr** accumulates through active slope processes. Slopes of **Qsr** are likely unstable and susceptible to continued slumping and sliding, particularly when rubble is disturbed. Erosion resistance is moderately low. **Abandoned mineral lands**— **Qsr** could be a mining target for aggregate.	**Glacial deposits and features**—unit records slope processes associated with postglacial conditions. **Paleontological resources**—Sparingly fossiliferous; areas of **Qsr** could be of interest to fossil collectors.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—Unit records accelerated weathering and slope processes associated with cold glacial and periglacial climates. **Qsr** occurs in thick aprons at the bases of cliffs on the west side of Minisink Valley.
	Olean ice-contact stratified sand and gravel (Qoic)	**Qoic** contains loose, stratified sand and gravel with occasional large boulders. **Qoic** was deposited by streams and flowing water near stagnant glacial ice. Thickness of **Qoic** deposits ranges from several meters to more than 60 m (200 ft).	**Slope movements**—erosion resistance is moderately low for this unit, and it is susceptible to slumping. Slumps and slides within **Qoic** caused road closures along Highway 209 at mile marker 15. **Dmh** also flanks the road along this stretch.	**Glacial deposits and features**—**Qoic** formed at the leading or retreating edge of glacial ice. **Connections to park stories and resources**—**Qoic** is associated with hummocky (irregular) surface topography and undrained depressions.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—Units were deposited by fluvial (river) processes in close proximity to stagnant glacial ice. The material in **Qokt** reflects local bedrock compositions.
	Olean kame terrace (Qokt)	**Qokt** contains loose, stratified sand and gravel, and commonly contains large boulders. The composition of beds and lenses of this unit may change abruptly. It ranges from several meters to more than 60 m (200 ft) thick.	**Slope movements**—erosion resistance is moderately low for this unit, and it is associated with sloping surfaces that could be prone to slumping.	**Glacial deposits and features**—**Qokt** includes valley-bottom and valley-side kames, some upland kames, and kame terraces. **Connections to park stories and resources**—**Qokt** is associated with hummocky (irregular) surface topography and undrained depressions, which may host wetlands.	

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QUATERNARY	Olean till (Qot)	**Qot** includes random mixtures of unsorted, nonstratified (layered) clay, silt, sand, pebbles, cobbles, and boulders. Thickness of this unit ranges from less than 1 m (3 ft) to more than 50 m (164 ft). In outcrop exposures, the till may appear reddish brown, brown, and gray, often dependent on the immediately adjacent bedrock.	**Slope movements**—unvegetated slopes are susceptible to mass wasting. Clay-rich layers, as well as till atop glacially polished bedrock are susceptible to landslides. Debris flows and slumps are also possible. Erosion resistance is moderately low. **River channel migration and flooding**—flooding may be an issue along stream valleys. **Surface water and groundwater quality and quantity**—permeability associated with this unit is highly variable and largely unpredictable.	**Glacial deposits and features**—**Qot** contains lodgment till (deposited from the base of glacial ice) and ablation till (deposited by sudden melting of glacial ice).	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qot** was deposited beneath melting glacial ice as a sudden dump of mixed material that had been entrained within the moving glacier.
	Talus deposits (Qta)	**Qta** contains unsorted (random sizes), loose, nonstratified (unlayered) angular boulders. Boulders can reach 4 m (15 ft) in length. Deposits of **Qta** as much as 6 m (20 ft) thick form aprons over rock and till at the bases of bedrock cliffs.	**Slope movements**—erosion resistance is moderately low. Unit is associated with active slope processes, such as blockfall and slumping. Infrastructure should be avoided at the bases of cliffs.	**Connections to park stories and resources**—unit contains quartzite and quartz-pebble conglomerate fragments. Possible source of replacement building stones.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qta** was deposited by rockfall after the retreat of the late Wisconsinan glacier (late Pleistocene) and continues to form in the Holocene. Unit records accelerated weathering and mass-wasting processes associated with cold glacial and periglacial climates. These processes continue at a subdued rate today. Unit is especially prevalent on the steep hillslopes of Kittatinny Mountain.
	Stream terrace deposits: Stream terrace deposits (Qst)	Units contain stratified (layered), well- to moderately sorted sand and silt. Beds of stream terrace deposits are massive (lacking bedding structures) to laminated and may be as much as 6 m (20 ft) thick. **Qst** forms terraces with surfaces up to 12 m (40 ft) above the modern floodplain. Exposures tend to be yellowish brown. Where more than one terrace level exists, such as in Minisink Valley, the younger terrace is called **Qst2** and the older, higher terrace is **Qst3**. **Qst2** lies 6 to 11 m (20 to 35 ft) above the mean annual elevation of the Delaware River and generally consists of 6 m (20 ft) of fine sand and silt above 6 m (10 ft) of pebble gravel and sand. **Qst3** lies 12 to 15 m (40 to 50 ft) above the river and consists of as much as 3 m (10 ft) of fine- and medium-grained sand.	**Slope movements**—erosion resistance is low. Units may be susceptible to erosion and slope processes when disturbed on slopes. **River channel migration and flooding**—terrace deposits along modern streams and rivers may be inundated during floods.	None documented.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—Stream terrace deposits mark former locations of the river above the modern valley. As evidenced by their positions atop glacial outwash and early postglacial fluvial sand and gravel, these units formed after the late Pleistocene glacial deposition ended. These abandoned floodplains record the change in the fluvial regime from a braided glacial meltwater-fed stream to its present incised, low-sinuous meandering course.
	Stream terrace deposits: Younger Minisink Valley terrace (Qst2)				
	Stream terrace deposits: Older Minisink Valley terrace (Qst3)				
	Eolian deposits (Qe)	**Qe** locally forms winnowed sand sheets and small dunes. In outcrop exposures, the sand and silt of **Qe** are very pale brown to yellowish brown and as much as 5 m (15 ft) thick.	**Slope movements**—erosion resistance is low. **Surface water and groundwater quality and quantity**—units are fairly localized and highly permeable. Wastewater treatment development should probably be avoided in **Qe**.	**Glacial deposits and features**—deposited by wind which transported sediment from unvegetated areas following glacial retreat.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qe** was deposited on unvegetated post-glacial surfaces during the late Pleistocene, early to middle Pleistocene, and Pliocene (on uplands). **Qed** formed just after glacial retreat during the late Pleistocene.
	Sand dunes (Qed)	**Qed** is fine to very fine sand that occurs in low mounds and ridges. The sand was transported by wind and overlies glacial outwash deposits in Minisink Valley. Deposits of **Qed** may reach 3 m (10 ft) in thickness and appear yellowish brown to brown in outcrop exposures.			

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Age	Map Unit (Symbol)	Geologic Description	Geologic Issues	Geologic Features and Processes	Geologic History
QUATERNARY	Glacial deposits, undifferentiated (Qg)	**Qg** is a map unit that may include till (see **Qot**), ground moraine, and stratified (layered) glacial drift deposits. Unit can reach up to 30 m (100 ft) in thickness.	**Slope movements**—erosion resistance is moderately low. Till atop glacially polished bedrock is susceptible to landslides. **Abandoned mineral lands**—quarried for sand and gravel. **Paleontological Resource Management**—a field-based park survey may uncover Pleistocene fossils within the park. **Surface water and groundwater quality and quantity**—permeability associated with this unit is highly variable and largely unpredictable.	**Paleontological resources**—Pleistocene units within the park potentially contain remains of mastodon, freshwater mollusks, elk-moose, turtles, turkeys, deer, peccary, horse, bison, woodchuck, chipmunk, squirrel, mouse, wood rat, vole, beaver, myotis, bat, mole, raccoon, weasel, skunk, gray fox, wolf, and lynx, among other Pleistocene flora and fauna. **Connections to park stories and resources**—The thickest deposits of **Qg** (more than 60 m [200 ft]) occur under Delaware River near Shawnee Island.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qg** records processes of deposition by glaciers during the most recent glacial advance (Wisconsinan) of the Pleistocene.
	Meltwater terrace deposits (Qmt)	**Qmt** contains stratified, relatively well-sorted sand, cobbles, pebbles, and gravels with minor amounts of silt. This unit was deposited by glacial meltwater streams as flanking terraces within valley-train (see **Qv**), glacial-lake delta deposits, and other meltwater terrace deposits. **Qmt** may be as much as 6 m (20 ft) thick.	**Slope movements**—erosion resistance is moderately low.	**Glacial deposits and features**—includes boulder strath terraces cut into glacial till deposits along meltwater stream courses in upland areas.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qmt** reflects abundant meltwater streams that formed as the last glaciers retreated from the area during the late Pleistocene. Terraces are traceable for long distances downstream and vary between distal and proximal (to glacial ice) deposits.
	Till: Derived from Kittaninny Mountain (Qtq) Till: Derived from Kittaninny and Minisink valleys (Qtk)	Units consist of scattered patches of noncompact to slightly cohesive, boulder "upper till" overlying a mantle of compact "lower till" that was deposited atop bedrock and some older (pre-Wisconsinan glacial period) surficial deposits. **Qtq** includes clasts of unweathered quartz-pebble conglomerate, quartzite, red sandstone, and red shale from Kittatinny Mountain. It appears yellowish brown, light olive brown, reddish brown, and brown in outcrop exposures that may reach 45 m (150 ft) in thickness. **Qtk** appears indistinctly layered and may be yellow brown or light yellowish brown in outcrop. Clasts in **Qtk** include unweathered slate, siltstone, sandstone, dolomite, limestone, chert, minor quartzite, and quartz-pebble conglomerate derived from bedrock outcrops in Kittaniny and Minisink valleys.	**Slope movements**—unvegetated slopes are susceptible to mass wasting. Clay-rich layers may be particularly unstable on slopes and prone to debris flows or slumping. Landslides are documented within glacial tills in the park, particularly where such units overlie glacially polished bedrock. Erosion resistance is moderately low. **Surface water and groundwater quality and quantity**—permeability associated with this unit is highly variable and largely unpredictable.	**Glacial deposits and features**—units are unsorted, reflecting the variety of materials entrained in glacial ice.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—Glacial till was deposited quickly and directly from glacial ice as it melted.
	Kame (Qk)	**Qk** contains layered, well- to poorly sorted sand, silt, pebbles, gravel, and occasional boulders in small collapsed hills and ridges. **Qk** is interlayered with and overlies glacial till deposits. It may be as much as 15 m (50 ft) thick. This lumped unit may contain kames, eskers, kame terraces, and kame deltas. Some portions of this unit may be rather solid with calcareous cement.	**Slope movements**—erosion resistance is low to moderate in this unit (cemented layers). Unit may be unstable on slopes and prone to rockfall where boulders weather out of sloped exposures. **Surface water and groundwater quality and quantity**—**Qk** has highly variable sorting, texture, and permeability, which make the prediction of its water-yield characteristics difficult.	**Glacial deposits and features**—**Qk** includes sediments that filled ice holes and crevasses within glacial ice.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qk** records the morphology and evolution of the glacier during the late Pleistocene (Wisconsinan) event.
	Glacial-lake delta deposits from proglacial lakes (Qod)	**Qod** includes stratified silt, sand, and gravel deposited by glacial meltwater streams into proglacial lakes that formed beyond and at the edge of a stagnant glacier margin. Thickness of **Qod** may reach as much as 45 m (150 ft) and the beds are yellowish brown, reddish brown, and light gray in exposures. Layers of **Qod** tend to occur in crossbeds that dip (are tilted) 20° to 35° toward the center of the lake basin. Further into the basin, the deposits become finer grained and are not tilted as steeply.	**Slope movements**—erosion resistance is moderately low.	**Glacial deposits and features**—surfaces of **Qod** deposits are very kettled (pocked with small, round depressions).	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qod** records the margins of a series of proglacial lakes, including lakes in Paulins Kill and Wallpack valleys, and Lake Owassa in the Kittatinny Valley, that formed as glaciers melted and retreated from the area.

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Age	Map Unit (Symbol)		Geologic Description	Geologic Issues	Geologic Features and Processes	Geologic History
QUATERNARY	Valley-train deposits (Qv)		**Qv** consists of stratified (layered), well- to moderately sorted sand, boulder-cobble to pebble gravel, and minor silt. **Qv** was deposited by meltwater streams originating at the glacier and extending more than 8 km (5 mi) beyond the glacier margin. **Qv** may be as much as 30 m (100 ft) thick.	**Slope movements**—erosion resistance is moderately low. **Surface water and groundwater quality and quantity**—units may form permeable, unconfined surface aquifers.	**Glacial deposits and features**—**Qv** contains bedding, crossbeds, troughs, and terraces, that reflect a fluvial origin. Channels and bars meandered across the landscape as the meltwater stream system developed..	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qv** represents an extensive meltwater stream system that developed at the margins of retreating glaciers during the late Pleistocene. **Qv** was deposited atop glacial lake deposits (see **Qod** and **Qd**) as glacial lakes drained and their basins filled with stream deposits. In places, thin eolian sand deposits (see **Qe**) overlie **Qv**, indicating windy, unvegetated conditions that existed after glacial retreat.
	Outwash fan	Near Branchville (Qf)	**Qf**, **Qfdb**, and **Qfa** are all stratified, well- to moderately sorted sand, cobble-pebble gravel, and minor silt deposits. Bedding within these units is tilted (dips) toward the larger, trunk valley by as much as 10°. Deposits may be as much as 18 m (60 ft) thick and grade into valley-train deposits (see **Qv**) from individual drainages at Branchville, Dry Brook, and Adams Creek.			**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—All three units formed as deposits at the mouths of individual streams where they joined the major drainage of the Minisink Valley during the last glacial retreat of the late Pleistocene.
		Dry Brook (Qfdb)				
		Adams Creek (Qfa)				
	Recessional moraine	Recessional moraine (Qwmrk)	**Qwmrk**, **Qdfm**, **Qom**, and **Qm** contain mixed sediments as much as 24 m (80 ft) thick that were deposited directly from glacial ice along recessional (retreating) ice margins. Some areas contain till (see **Qtq**). Sediments include unstratified to poorly stratified sand, gravel, and silt. Recessional moraines locally overlie till deposits in uplands and outwash deposits in river valleys. **Qdfm** and **Qom** have nearly identical compositions where they occur at Dingmans Ferry and Ogdensburg-Culvers Gap, respectively.	**Slope movements**—erosion resistance is moderately low. Ridges may be mantled by boulders that may be prone to rockfall.	**Glacial deposits and features**—segmented ridges in these units mark former lobate (tongue-shaped) glacier margins. Surface topographies of these units may be irregular (hummocky) and form ridges and knolls.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qdfm** was deposited at the active margin of the Kittatinny and Minisink Valley ice lobes.
		Dingmans Ferry (Qdfm)				
		Ogdensburg-Culvers Gap (Qom)				
		Recessional moraine (Qm)				
	Glacial-lake delta deposits-Lake Owassa (Qd)		**Qd** includes stratified silt, sand, and gravel deposited by glacial meltwater streams into proglacial lakes that formed beyond and at the edge of a stagnant glacier margin. Thickness of **Qd** may reach as much as 30 m (100 ft) and the beds are yellowish brown, reddish brown, and light gray in exposures. Layers of **Qd** tend to occur in crossbeds that dip (are tilted) 20° to 35° toward the center of the lake basin. Further into the basin, the deposits become finer grained and are not tilted as steeply.	**Slope movements**—erosion resistance is moderately low.	**Glacial deposits and features**—the surfaces of **Qd** deposits are very kettled (pocked with small, round depressions).	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qd** (much like **Qod**) was deposited in glacial Lake Owassa, which formed in the Kittatinny Valley in successively younger deltas that advanced (prograded) basinward as deposition progressed.
	Outwash fan-Dingmans Creek (Qfd)		**Qfd** is stratified, well- to moderately sorted sand, cobble-pebble gravel, and minor silt deposits in fan-shaped lobes. Bedding within these units is tilted (dips) toward the larger, trunk valley by as much as 10°. Deposits may be as much as 18 m (60 ft) thick and grade into valley-train deposits (see **Qv**) from individual drainages at Dingmans Creek.	**Slope movements**—erosion resistance is moderately low. **Surface water and groundwater quality and quantity**—these units are all relatively well drained and may function as unconfined surficial aquifers.	**Glacial deposits and features**—units were deposited by glacial meltwater.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qfd** formed as deposits at the mouth of an individual stream where it joined the major drainage of the Minisink Valley during the last glacial retreat of the late Pleistocene.
	Glaciofluvial terrace deposits (Qwft)		**Qwft** contains sand, pebble-to-cobble gravel, and minor silt in yellowish-brown to reddish-brown exposures as much as 12 m (40 ft) thick. These terraces formed along the courses of glacial meltwater streams.			**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qwft** and **Qwfv** record the presence of glacial streams that formed during the melting of the late Pleistocene glaciers.
	Glaciofluvial plain deposits (Qwfv)		**Qwfv** formed by meandering glacial streams as a planar surface. **Qwfv** contains sand, pebble-to-cobble gravel, and minor silt in yellowish-brown to reddish-brown exposures as much as 24 m (80 ft) thick.			

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QUATERNARY	Ice-contact deposits (Qwic)	**Qwic** contains sand, pebble-to-cobble gravel, occasional boulders, and minor silt deposits. In exposures as much as 45 m (150 ft) thick, this unit appears yellowish brown to reddish brown.	**Slope movements**—erosion resistance is moderately low. **Surface water and groundwater quality and quantity**—these units are all relatively well drained and may function as unconfined surficial aquifers.	**Glacial deposits and features**—**Qwic** occurs as knolls and ridges that are higher than adjacent glacial-lake levels or glaciofluvial plains (see **Qwfv**).	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qwic** formed in ice-walled basins during the late Pleistocene glaciation.
	Older till (Qit)	**Qit** occurs as grayish to dark-yellowish-orange and brown, deeply weathered, mixed deposits of silt and clay with occasional cobbles. Unit may be as much as 6 m (20 ft) thick.	**Slope movements**—till atop glacially polished bedrock is susceptible to landslides. Debris flows and slumps are also possible. **Surface water and groundwater quality and quantity**—clay-rich units such as **Qit** may form relatively impermeable layers that can underlie wetlands. Permeability associated with this unit is highly variable and largely unpredictable.	**Glacial deposits and features**—till formed as mixed deposits when ice melted quickly and dumped all entrained material at once.	**Gap formation, ice age glaciation, and Appalachian Mountain erosion**—**Qit** represents deposits from a glaciation (Illinoian?) that occurred earlier than the last glacial maximum (Wisconsinan) in the late Pleistocene.